~~60.~~ 16 (Amended) A method for treating the surface of an article <u>having a surface comprising an inorganic element or oxide thereof</u> comprising <u>hydrating said surface to form thereon a monolayer of water, and then reacting</u> [contacting] said surface with silanes of the formula R^1SiX_3 and R^2SiX_3, wherein R^1 and R^2 are hydrocarbyl substituents and X is a leaving group, provided that R^1 is longer than R^2, under conditions whereunder said silanes react at said surface and form a monolayer of silicon atoms chemically bonded to said surface which silicon atoms are connected to other silicon atoms in said monolayer through oxygen atoms in said monolayer, wherein each of said silicon atoms in said monolayer is substituted with R^1 or R^2 <u>and wherein the density of said hydrocarbyl substituents in said monolayer is at least 7 micromoles per square meter of substrate surface,</u>

<u>wherein said inorganic element is selected from the group consisting of Al, Zr, P, Be, Mg, Ti, V, Cr, Mn, Fe, Co, Ni, Cu, Zn, Ga, Ge, As, Rb, Sr, Y, Nb, Mo, Ru, Rh, Pt, Au, Ag, Tl, Pb, and Bi</u>.

<u>Please cancel Claims 6 and 7</u>.

<u>REMARKS</u>

Applicants hereby respond to the Official Action mailed February 25, 1997 in the above-captioned application. Entry of the foregoing amendments and reconsideration of claims 1-5, 8-13, 27-28, 49-51 and 60-68, as amended herein, are respectfully requested. Claims 6 and 7 have been canceled.

The claims have been subjected to a requirement to designate a single disclosed species for prosecution on the merits. The undersigned attorney for applicants hereby affirms the previous telephonic provisional election, on February 21, 1997, of inorganic elements or oxides thereof as the substrate, in response to that requirement. In addition, in response to

the requirement to designate claims readable on the designated species, applicants submit that Claims 1-13, 27-28, 49-51 and 60-68 are readable on the species designated herein.

The applicants thank the Examiner for her helpful suggestions on page 4 of the Official Action. Accordingly, the present claims have been amended consistent with the amendments made in the parent application, U.S.S.N. 08/455,875, now U.S. Patent No. 5,599,625. In view of the Examiner's comments, that "claims drawn to the elected species and having the same product by process and density limitations as the claims in the parent application, would place the application in condition for allowance", the applicants respectfully submit that the present claims, as amended herein, are in condition for allowance.

In addition, Claims 1, 49 and 60, the main independent claims, have been amended to recite the specific inorganic metals recited in Claim 7, now canceled, of the original disclosure. The Applicants have provided these amendments to ensure that there is no overlap in subject matter between this application and the parent application, U.S.S.N. 08/455,875, now U.S. Patent No. 5,599,625.

Although the Examiner has indicated that if applicants effect the aforementioned amendments, the claims will be in condition for allowance, in accordance with 37 C.F.R. §1.111, the applicants offer the following comments so as to fully respond to every ground of objection and rejection raised by the Examiner in the present Official Action.

Claims 1-13, 27-28, 49-51 and 60-68 stand rejected under 35 U.S.C. §103 as unpatentable over U.S. Patent No. 5,209,976 ("Ogawa"). This rejection is respectfully traversed for the following reasons.

According to the Examiner, Ogawa teaches a monomolecular film bonded to the surface of a substrate via Si-O bonds. Example 1 of the reference teaches that the substrate covered by this film can be a metal or metal oxide and further teaches that silane agents are used to form the monomolecular film on the surface of the substrate. The Examiner acknowledges that Ogawa fails to expressly teach the use of two hydrocarbyl groups, one longer than the other. To the Examiner, selection of applicants hydrocarbyl groups, of the lengths recited, would have been obvious to the skilled artisan. The rejection is respectfully traversed.

The applicants respectfully submit that, as will be shown below, Ogawa fails to teach or suggest the numerous differences between the reference and present claims.

Claims 1, 49 and 60, the main independent claims in this application, have been amended to recite that the product of claim 1 and the processes of claims 49 and 60, include a formation step in which the surface of the substrate is hydrated to form on said surface a monolayer of water, following which the hydrated surface is reacted with silanes of the formulas R^1SiX_3 and R^2SiX_3, wherein R^1 and R^2 are hydrocarbyl substituents and X is a leaving group, under conditions such that those silanes react at the surface and form the monolayer of silicon atoms. This aspect of the presently claimed invention, including the formation of the monolayer of water, is disclosed in the present application, particularly at page 12, lines 19-26, which also teaches how to attain the desired monolayer of water on the substrate surface. The observation of this step, i.e. obtaining a monolayer of water on the substrate surface, leads in turn to achieving the significantly and unexpectedly high substituent density of at least 7 micromoles per square meter of substrate surface.

The products and processes claimed by applicants are characterized by a combination of features not taught or suggested by Ogawa. These include: a monolayer of silicon and oxygen atoms is formed in which the silicon and oxygen are cross-linked, i.e. interconnected to each other in the plane of the silicon monolayer; this silicon monolayer is substituted with first and second hydrocarbyl substituents of different lengths; the density of the hydrocarbyl substituents is at least 7 micromoles per square meter of substrate surface; and this product is formed by forming a monolayer of water on the surface of the substrate and reacting the thus hydrated surface with silanes of the formula R^1SiX_3, and R^2SiX_3 such that the silanes react at the surface and form the desired monolayer of silicon atoms. Ogawa neither teaches nor suggests any of these features. The Official Action acknowledges that Ogawa fails to teach two hydrocarbyl groups of different lengths, and fails to teach the particular density of the hydrocarbyl groups.

Applicants respectfully submit that Ogawa contains no teaching or suggestion whatsoever of a silicon monolayer having a substituent density of at least 7 micromoles per square meter of substrate surface. In addition, applicants note the amendments made herein to the claims in respect of the process by which the desired monolayer is formed, namely, that a monolayer of water is formed on the surface of the substrate and then the monolayer of water is reacted with silanes to form the desired cross-linked and heavily substituted monolayer of silicon atoms. This step by which the applicants carry out their invention is an essential step for achieving the desired high degree of cross-linking and substitution of hydrocarbyl substituents, as is pointed out for instance at page 12 of applicants' specification.

Ogawa completely lacks any teaching or suggestion that would lead one of ordinary skill in this art to form a monolayer of water on the substrate surface prior to reaction with the silanes. Instead, it is clear that Ogawa discloses only conditions under which the desired monolayer of water required by applicants could not possibly be formed; thus, Ogawa is not only silent of any recognition of the necessity of forming a monolayer of water, but Ogawa also in fact teaches away from possibly forming such a monolayer of water. Specifically, Ogawa in column 2, in Example 1 beginning at line 40, discloses evaporating and solidifying a metal or metallic oxide in a vacuum to form an ultra fine particle; clearly, such conditions could not possibly deposit a monolayer of water on the ultra fine particle formed in this manner. The Example goes on to state that the ultra fine particle is dispersed, in situ, in an organic solvent such as chloroform in an inert atmosphere "of N gas, etc."; again, exposing the particle to such conditions would not permit formation of a monolayer of water on the surface of the particle. Rather, such conditions would appear to one of ordinary skill in this art to be chosen so as to prevent the possibility that a monolayer of water could be formed on the particle. Ogawa's Example goes on to state that the ultra fine particle is immersed in a solution of 80 wt.% n-hexane, 12 wt.% carbon tetrachloride and 8 wt.% chloroform, in which is dissolved silane surface agents. These conditions, as well, lead one of ordinary skill in this art to conclude that the formation of a monolayer of water on the particle surface is not taught or suggested.

Thus, the claimed process steps by which applicants carry out their invention are not obvious from Ogawa. Applicants' products and processes as claimed are thus unobvious, and patentable, as applicants have shown that those

process steps are essential to the formation of unique products and to the superior properties of those products.

For all the foregoing reasons, applicants respectfully submit that the invention designated in response to the species designation requirement is patentable; and that claims 1-5, 8-13, 27-28, 49-51 and 60-68 are in condition for allowance which action is earnestly solicited.

Respectfully submitted,

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